Monetary Policy in China: The Fisher Effect

Yan Peng

A dissertation submitted to
Auckland University of Technology
in partial fulfilment of the requirements for the degree of
Master of Business (MBus)

2007

School of Business

Primary Supervisor: Ming-Hua Liu

Table of Contents

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of a higher learning.

Acknowledgements

I am greatly indebted to my supervisor Professor Ming-Hua Liu for all his help. It would be impossible to adequately describe the extent of his support and encouragement during my postgraduate study and work on this dissertation. Without his help and advice, it would not have been possible to complete this dissertation. I thank Dr. Thomas Samuel for torturing me on EViews and for the countless conversations in which he taught me so much about economics. His criticisms and suggestions improved my empirical analysis tremendously. I would also like to thank my friend, Thomas Tran, for helping me refresh both my statistics and econometric knowledge and for providing invaluable support and advice. In addition, I want to thank everyone in my family for their love and support. I dedicate this work to them.

Abstract

This paper analyzes the Fisher effect and tests the validity of the Fisher hypothesis in China. Taking into consideration the short run dynamics of interest rates, we examine the Fisherian link in China by assessing the long run relationship between nominal interest rates (deposit rates) and inflation rates. In doing so, we apply the methodology, paying attention to the unit root and cointegration properties of the variables, since the meaningful Fisher effect critically depends on those properties. The empirical results indicate that the nominal rate of interest in China was nonstationary during the years 1993-2005 and unit root nonstationarity is rejected for this period as well. We find there is one long-term cointegration relationship between inflation and interest rates but is not significant. All the coefficients are significantly different from zero but all are different from one. This supported the argument that the policy experiments in China has less inflation targeting and active monetary policy, but stronger targeting economic growth, job creation and financial stability.

List of Tables

Monetary Policy in China: The Fisher Effect

1 Introduction

The relationship between interest rate and inflation is one of the most studied economic parity relations today. This is partially because of its importance and partially because of the fact that conflicting empirical evidence suggests the existence of such a relation on both a long and a short run basis; nonetheless, there have been few satisfactory explanations. This type of relationship, formally documented Irving Fisher, is known as the Fisher effect. It states that in the long run a one percent increase in inflation will be accompanied by a one percent increase in the nominal interest rate leaving the real interest rate unchanged (Fisher, 1896, 1930).

Numerous empirical analyses have been done and various models have been proposed and tested (using data from both developed and developing countries) for the Fisher effect. Interestingly, the existence of the Fisher effect has been subject to debate. Its importance, however, is unarguable. From a macro-economic perspective, the Fisher effect is the cornerstone of neutrality monetary models (i.e. money supply) and it is critical in explaining the movement of other economic fundamentals (i.e., exchange rate). More importantly, because inflation is the fact of life in economies, and because of the difference between nominal and real interest rate, which affects all inter temporal savings and investment decisions in the economy, the understanding of the Fisher link – the relationship between inflation, nominal and real interest rate – is the key to gaining knowledge about how each economy runs as a whole and how different economies interact.

Given the importance of such a relationship, academicians and researchers have been compelled to find the answers to two basic questions. Firstly, does the Fisher effect

exist universally in all economies? Specifically, in all developed and developing countries? If it presents in developing countries and then holds, in what manner does it do so? Does it hold in a weak or a strong form? Does it hold in the long run or on a short run basis?

The purpose of our research is to find answers to these questions by extensively examining data from the Chinese economy, which is well known as a developing economy and for its high and stable growth rate. Using the Chinese economy for this study provides two folds in the context of economic attributes. Firstly, among other developing economies in Asia, the Chinese government has purposely run the economy to achieve a constant growth rate and that constant growth rate has been praised as a miracle by economists. Consequently, being able to establish the existence or non-existence of the Fisher effect in such an economy will add knowledge to the debate on the relationship between inflation and interest rate. Secondly, the Chinese economy is characterized by the fact that it is still in the transitional stage from a central planned economy to a market. Hence, economic decisions made by governmental institutions have not been purely market driven. In particular, as stated in Liu, Margaritis and Tourani-Rad (2006), interest rates in China are often controlled by the government and kept intentionally low for its multiple policy objectives.

Fundamentally, the main objective of economic decisions is to increase the productiveness of an economy. However, interestingly it has been documented that China's investment has not been targeted at productive enhancement activities, but rather channelled to parts of the economy that can maintain pace of growth. *The Economist* (2005) reports that to generate a one US dollar increase in output, China requires about five US dollars of fresh capital, which is considered to be unsustainable for any other country. These counter productive numbers would become even worse if

the total cost of population and environmental degradation is fully quantified. We believe that these will significantly darken the productivity of the countries' economy as the World Bank has documented that 16 out of the 20 worse polluted cities are in China. In addition, it is estimated that pollution costs China between 8 to 12 percent of whole GDP each year. The question that arises here though is what rationale is for the government to allow such poor economic decisions to be made. Not surprisingly, for the Chinese government, the appearance of a growth and stable economy, which generates desirable unemployment figures, is even more important and urgent than investment productivity.

Despite the strong intent of the government to counter unemployment, the problem appears to have remained an acute issue because the number of laid-off workers kept escalating. A potentially severe problem for China is its huge population, which is expected to peak at 1.5 billion. Consequently, the majority of newly created employment opportunities will simply be consumed by the increase in population and it is highly likely that big cities will eventually be flooded with waves of unemployed people from rural areas. *The China Daily* (2004) estimated that there were about 150 million workers in the surplus labour supply. The government estimated the rural proportion of the work force in the cities to be about 60 million between 2003 and 2010. In China, it is rare for the government to admit any governmental shortcomings, but the seriousness of the unemployment issue reached the point where it is reported that the Economic Planning Committee and the Minister of Social Security had admitted that unemployment was indeed a serious problem for the country (Sun & Tong, 2000).

In an analysis of the previous facts, it is not surprising that the Chinese government has given economic activities that create employment opportunity a higher priority than sound economic improvement ones. Liu et al (2006) postulated that one of the measures

that was pursued was “to promote employment through economic growth by discouraging saving and stimulating consumption to promote growth.” In addition, the government has also set economic growth as a governmental target for its long-term economic plan. Another characteristic, worth mentioning, of the Chinese monetary policy: is that China has one of the highest saving rates in the world, over 40%, and a very large proportion of this ends up in bank deposits. This is because alternative investments are still limited in China as the financial market is still in its early stage of development. It is reported in Sun and Tong (2000) and Kang, liu, & Ni (2002) that only 10% of Chinese savings is in the form of bonds and equity. From a lending perspective, bank loans have been the only source of capital for borrowers and they are provided by four state-owned banks. Since both deposit and lending interest rates are controlled directly by the central bank, it would appear that interest rate changes would have an immediate and significant impact on the Chinese economy. In reality, however, the reaction of the economy seems to lag behind the effect of changing interest rates and it is only somewhat sensitive to interest shocks.

In most countries, central banks are responsible for formulating and implementing their own monetary policy. However, in socialist countries, like China, monetary policy is not set by bodies that are politically independent from the government. Instead, they are driven by political process (e.g., the monetary policy is designed in such a way as to increase employment). The government controls the monetary and fiscal policy via the People’s Bank of China. This is completely opposite from the system in all major developed countries, such as Australia and New Zealand, where the governor of the reserve bank makes monetary decisions without any interference from politicians. In New Zealand, interest rates are mainly driven by demand and supply for funds and have been used as a tool to tackle inflation, which is kept subject to a certain target. As can be

recently seen, the governor of the reserve bank has increased the official cash rate to axe demand for home loans and to suppress the inflation rate.

The Chinese government has not only had its hands on monetary policy, but also on the tools to apply these policies to the economy. Prior to 1994, monetary policy (i.e., money supply) was carried out in a top down fashion, meaning the central bank directly lent to the four state-owned banks, which then executed monetary policy (i.e., injected money into the economy). Between 1994 and 1999, the rapid growth of direct foreign investment resulted in the use of the sterilization of foreign reserves as a major tool in the control of monetary policy. In 1998, the system of credit quotas allocated to national banks was abandoned and paved the way for the open market operation to become a main channel for controlling the monetary base and money supply. Among other tools were reserve requirements, rediscounting, and the guidance of credit orientation. In 1996, the Central Bank of China gradually deregulated its politically driven interest rate setting mechanism by establishing the inter-bank money market and removing controls over the inter-bank offer rate. A marked event in the deregulation process was the establishment of the inter bank bond market in June 1997 and the lifting of the control over the interest rate on the RMB borrowings by central banks, which led to abandoning the interest rate ceiling for deposits over 30 million Yuan with a minimum maturity of five years. Most recently, restrictions on lending rates were lifted in 2004. However, domestic currency deposit rates are still under close watch by the Central Bank.

Based on the Mundell-Fleming model, the feasible region for monetary policy is to combine any two of the "impossible trinity," maintain a fixed exchange rate, free capital flow, and independent monetary policy (Laurens, Maino, & Stella, 2007). Although each country chooses its own monetary policy, there are still lessons we can learn. Since the 1990s, there have been a large number of industrial countries and a growing number

of emerging economic countries, which now conduct domestic inflation targeting administered by the independent and transparent central banks. Additionally, as a result of its manifest success in the international monetary system, inflation targeting has already and will continue to spread rapidly in more and more developing countries (Rose, 2007). Recently, along with the maintenance of the high growth rate of the Chinese economy, an avalanche of heated discussion and arguments are surfacing on the global imbalances and the devalued RMB/USD exchange rate related to the still fixed exchange rate policy. Like most countries did during the "Bretton Woods" era, a vocal group of economists and researchers have advocated conducting inflation targeting for Chinese monetary policy, consistent with floating the exchange rate in the context of the Taylor rule. Goodfriend (2006) suggested that a low inflation objective of monetary policy, compared with a "full-fledged inflation targeting regime", could be the most reliable way for China to contribute to overall macroeconomic stability, sustained employment, and financial stability for meeting the objectives of monetary policy, as it is undergoing a marked transition in a variety of dimensions, despite the existence of numerous impediments.

Consequently, the analysis of the current monetary policy in the context of interest rate and Fisher effect in China is meaningfully important. This study is to examine the Fisher effect in the Chinese economy and present empirical evidence on the Fisher effect based on the economic system in China. Using the application of Granger-cause (Engle & Granger, 1987) and Johansen (1991) co-integration analysis properties of the variables, we test the classic Fisher equation for China, since the meaningful Fisher effects critically depend on those properties.

The remainder of the study is organized as follows. In Section 2, before moving to the technical analysis of the Fisher effect in the Chinese economy, we give a background

introduction and brief discussion of China's monetary policy to help understand the implementation of the monetary policy in China. Section 3 gives a brief literature review on the Fish effect and monetary policy. In Section 4, we describe the main model applied to the empirical analysis and the data employed. In Section 5, we investigate the fisher effect in China and present the empirical evidence. The final section gives a brief summary and conclusions.

2 China's Monetary Policy

Over time, a set of monetary policy instruments has been developed. They are reserve requirements, a central bank base interest rate, rediscounting, central bank lending, open market operation, and other policy instruments specified by the State Council (China, 2004). The primary instruments of monetary policy, used by the PBC, are open market operations, the discount rate, and reserve requirements ratio, which are similar to those used by most advanced central banks.

Under the guidance of the State Council, the Monetary Policy Committee of China was established by the People's Bank of China; the State Council regulates its functions, the composition, and the working methods. The Committee performs its function through regular quarterly meetings; its meeting minutes are recorded to the Standing Committee of the National People's Congress[1]. The Monetary Policy Committee of the PBC (the

[1] The Committee is an advisory organization on the formulation of the monetary policy and of its functions, on the basis of analysis it supplements the macro-economic situation, according to the objectives' of the macro-order of the state, and discusses the formulation and adjustment of monetary policies. For a certain period of time, the monetary policy committee is responsible for control of monetary policy goals, the use of the monetary policy tools, relevant measurements of the monetary policy, the coordination of the macro-economic policies of other principal questions related to the monetary policy, and to make recommendations. In other words, the monetary policy committee's duties can be divided into four areas: (1) formulating and adjusting monetary policy, (2) setting the target of monetary policy in a certain period, (3) implementing the tools of monetary policy, (4) co-ordinating the monetary policy with other macro-economic policies.

Committee) plays an important role in the formulation and adjustment of the monetary policy and in the management of macroeconomics.

2.1 China's monetary policy reform

China's monetary policy reform has experienced three phases since the late 1980s. Before 1986, China still relied on a centrally-planned economic system, just like other socialist and most developing countries such as the Soviet Union, and Vietnam. Changes occurred during the period from 1986 to 1993, when the PBC first adopted control of currency circulation and banks' loan portfolios as its intermediate monetary targets. In addition, the dual goal of achieving currency stability and promoting economic development has been changed to maintain the stability of the value of the RMB and thereby promote economic growth until December 1993.

Since the 1990s, China has undergone an overall economic monetary policy reform that has been dramatically consistent and been characterized by a gradual transition from a central- planned framework toward to a market-based monetary strategy framework; whereas its monetary system is in the midst of transforming from "one dominated by direct control measures to one with a more indirect approach based on open market operations" (Carrasco, 2003). The Second phase subsequently began. The first practice on market-based policy was in September 1994, the PBC announced three money supply indicators, M0, M1 and M2; then in 1996, along with the inter-bank money market, went into operation, the growth in the money supply replaced credit ceilings for reaching the intermediate monetary objective.

The third phase started in 1998, when the PBC eliminated the quantitative credit controls or the credit ceiling, and set the money supply as the single intermediate target. Since then many market-based tools and approaches around the goals of stable

exchange rate and economic growth (inflation indeed) have been implemented. Under such a monetary framework, M2 is set as an intermediate target and reserve money is set as the operating target. In 1999, China introduced open market operations, which played a role in adjusting money supply and liquidity, thereby guiding money market rates. Inconsistent with this transmission, previous state-owned banks have been allowed to transit into joint-stock commercial banks. In the mean time, the PBC authorized the qualified commercial banks and financial institutions to engage in direct trading of treasury securities, policy debentures, and PBC securities with the Central Bank. Nonetheless, the adjustments to the discount rate still remained by PBC as a key pillar of monetary management to control the growth of monetary aggregates (Carrasco, 2003).

In 2002, the most noteworthy of the economic reforms was the announcement of the Qualified Foreign Institutional Investor (QFII) program by the Communist Party Conference. Under this program, China is indeed taking the first steps toward capital account liberalization allowing foreign investors to have access to China's domestic equity and debt market.

Additionally, in 2007, according to the State Council's overall arrangements, the PBC continued to implement "a sound monetary policy" and timely adopt a comprehensive package of policies for strengthening macro-economic adjustment and maintaining balanced monetary aggregates through such avenues as open market operations and reserve requirement policies. Since the beginning of 2007, the PBC has increased four times in the reserve requirement ratio of financial institutions by two percentage points to withdraw excess liquidity in the banking system. As leverage, the benchmark deposit and lending rates of financial institutions were raised again as well. Meanwhile, the PBC has put large efforts on steadily promoting the reform of financial institutions and

guiding financial institutions to optimize the credit structure through the China Banking Regulatory Commission (CBRC).

2.2 Exchange rate policy reform

In early 1994, the dual exchange rate system was unified and replaced by a managed floating-rate system since 1995. In late 1996, RMB was made convertible for current account transactions but not for capital account transactions. Under this system, monetary policy is based on a money growth and exchange rate targeting framework. The PBC publishes a daily base cross rate of the RMB against the US dollar and other foreign currencies to the market based on the previous day's closing rates to adjust the money demand and supply in the monetary market. However, the RMB against the USD retained at an essential fixed level (Carrasco, 2003).

On July 21, 2005, the PBC revalued the RMB against the US dollar by 2.1 percent and allowed a fluctuation of the rate up to 0.3 percent per day, under which the government announced that the value of RMB would henceforth be set with reference to a basket of currencies,[2] rather than having it pegged to the US dollar only. However, the bare movements of the RMB against the US dollar, since July 2005, made no sense in relationship to the composition of the reference basket (Carrasco, 2003). Thus, it was concluded that the RMB was actually at a fixed parity relative to the US dollar (Goodfriend & Prasad, 2005).

[2] The authorities have indicated which currencies are included but not indicated the weights attached to each of them.

2.3 Interest rate policy reform

Interest rate policy is one of the most important components and is linked with the financial sector reform. As a main tool in the implementation of the monetary policy in China, the PBC adjusts interest rates and its structure for the purpose of money aggregate control and specific objective achievement. As stated by the 16th Party Congress, interest rate reform is treated as an advanced steadily optimized resource allocation and summarized as a transit to market economy. Then concerns from the PBC relies on the pace of implementation and how to balance it with financial stability and the health development of the financial sector (China, 2004). However, no matter which procedure was involved, we can still notice that the PBC still puts more hands on credit allocation than on interest rate adjustment.

The basic scheme of the reform began in 1993. The 14th Party Congress first stated that the long-run objective of interest reform was to create a market based interest rate management system through adjusting the Central Bank interest rates on the base of controlling the money demand and supply in market. The 3rd Plenary Session of the 14th Party Congress pointed out that the Central Bank needed to adjust the Central Bank base interest rates to the changes of money demand and supply and allow certain flotation of inter-bank lending and deposit rates. In 2003, the 16th National congress reported that there was a need to improve interest rate market reforms and optimize financial resource allocation. 1n 2003, the 3rd Plenary Session of the 16th Central Committee laid out clearly out that a robust mechanism for market-based interest rates in a direction consistent with economic objective was necessary (China, 2005).

Gradualism is applied to sequencing the liberalization of interest rates. Guided under the spirit of the 3rd Plenary Session of the 16th Central Committee and consistent with the commitment of open economy after joining into the WTO, the PBC crafted the basic

procedure as: local currency after foreign currencies, deposit rates after lending rates, retail after wholesale transaction, short-term and small amounts after long-term and large amounts. As stated by Zhou Xiaochuan, (Zhou, 2005) Governor of the PBC, removing the limits might result in improper market competition, the long-period move may help the PBC prevent risk, maintaining the sound momentum of sustained, rapid, coordinated, and healthy development of the domestic economy (Carrasco, 2003).

In 1996, the interest rate reform was officially approved in advance by the State Council. On June 1, the PBC opened the market for benchmark lending rates. The benchmark interest rate hike of RMB loans was conducive to containing over-investment, balancing the relationship between investment and consumption, and guiding a rational pricing of assets. This was followed by a series of restrictions, which were lifted on wholesale transactions; on June 1997, the PBC liberalized the inter-bank securities market rates and opened the primary markets for government securities on August 1998. In addition, the PBC adjusted the refinancing rate and made it a reference rate for the money markets. Consequently, the wholesale transactions were all open.

In another part, considering retail banking operations, the PBC set the rediscount rate as a unique tool and reference rate to allow the financial institutions to price their own lending rates within a floating margin to counter market risk since 1998. In addition, the Central Bank also expanded the floating margin in 1998 and 1999. On October 1999, the PBC began to liberalize deposit rates of the large and long-term amounts as well, although there were ceilings on lending rates and a floor on deposit rate differentiating in terms of capital capacity and commercial industrial accounts until 2004. However, the Central Bank retained a floor for lending rates and a ceiling for deposit rates differentiated by maturity (Laurens et al., 2007).

Regarding the foreign currencies market, in September 2000, the PBC opened the lending and deposit rates on foreign currencies with large amounts; those with small amounts (less 3 Million USD) were not opened till July 2003, although there exists a ceiling for deposit rates. On March 2002, the PBC unified the policies to local and foreign financial institutions.

Although many efforts have been handed down by the central government to liberalize the interest rate, its reform is not yet complete and there were only minor adjustments on interest rates that remain subject to administrative guidelines with some bans against lending to small and medium enterprises and rural credit cooperatives (Carrasco, 2003). Significant evidence demonstrates that little change was made until the present day. By 2006, largely driven by investment, the economy had been growing at roughly 10 percent in each of the past three years. The increasing widespread speculation was mainly in real estate, duplicated by investment on roads, factory equipment, and other fixed assets. On April 28, trying to further restrain the commercial banks lending capacities, the PBC made a first increase on the minimum rate commercial banks charge on one-year loans in Yuan, 27 basis points, to 5.85 percent in an aggressive move to discourage lending since October 2004 and were issuing three trillion Yuan bills to them. However, the PBC left the interest rate on deposit unchanged as China was hoping its consumers would contribute more to economic expansion and maintain the pace of economic growth. Furthermore, the Chinese government authorized the commercial bank to limit and tighten the loans lending to those area investments to cool the economy and lift the down payment requirement for house purchase and to cool down the heated real estate market as well. Unfortunately those administrative approaches seemed of little affect on the pursuit of loan profits (Xinhua, 2006). Again, the latest announcement on June 13, 2007, with the non-stop over expending on road,

metal around the countries, Premier Wen Jiabao served notice, after a meeting of his cabinet, that further monetary tightening and investment curbs were on the way (Vidaillet & Chen, 2007).

2.4 Summaries of obstacles for reform

Notwithstanding the apparent achievement and wide range of instruments available to the PBC, there exist explicit barriers for reform. For example:

- The Committee and the PBC are all under the leadership of the State Council. There is no meaningful independent policy maker;

- Management controlled exchange rate limits the liberalization of the interest rate;

- Interest rates are set based not only on the pursuit of inflation control, but the attempts to encourage and maintain the pace of growth for political concerns, including employment ability, and the stability of the whole country from the economic bubble;

- Oral guidance and administrative interpretation from the government conducting the operation of the banking system reins in the banks ability to compete in the market. Hopefully this stops after the commitment of the open bank market to the WTO.

- There are huge amounts of excess reserves at the Central Bank to control. Over-investment leads to an ineffective monetary policy in the context of responding flexibility to market shocks.

3 Literature Review

3.1 Fisher effect

Since Fisher (1896) formalized the notion of a real rate of interest, the concept has played a significant role in the formulation of a wide range of economic models. To name but a few, these include individual agent decision making regarding investment, savings, and portfolio allocations, options pricing models in finance, and the modern theory of inflation targeting in macroeconomics. Naturally, in light of the role that the real rate plays in economic theory models, Phillips (2005) states that a good deal of attention has been devoted in the literature, especially in macroeconomics, to the measurement of the real.

The empirical evidence of the Fisher effect that has been found in the literature appears inconsistent. Boudoukh and Rechardson (1994) reported that a positive relationship between interest rate and expected rate of inflation exists at all data durations. In contrast, Mishkin (1992) argues that such a relationship only holds in the long run in the USA. Using data from the German economy, Yuhn (1996) reported that the Fisher effect is strong over the long horizons and can be detected over short term data. This may be the result of what has been widely accepted and that is that the strength of the Fisher effect depends on the country and the length of period studied. In the quest to find answers to this research consensus, Berument and Jelassi (2002) conducted research that they claimed to be the most extensive study on the Fisher effect in term of the number of countries included in the data, 26 countries from both developed and developing countries was included. Econometrically, the model used in their research was simple. They tested for a positively linear relationship between expected inflation rate as an explanatory variable and interest rate as a response variable. If the coefficient estimate of the independent variable is positive and equal to one, then there is a one-to-

one relationship between the inflation rate and the interest rate and the Fisher effect is in strong form. However, if the estimated coefficient is positive, but less than one: then the Fisher effect is in weak form. The authors found that the Fisher effect existed in the strong form in 16 out of 26 countries. Interestingly, they concluded that the Fisher hypothesis holds more for developed countries than for the developing ones.

Adding the effect of taxation to the puzzle of the Fisher effect, Darby (1975), Feldstein (1976), and Tanzi (1976) have shown that because of taxation, nominal rates must change by more than the change in expected inflation if the real after tax rate of interest is to be invariant to anticipated changes in the value of money. This effect produces an "augmented" Fisher effect. Darby (1975) suggested that the nominal rate should change by 1.3 to 1.5 times the change in expected inflation. A number of studies have found estimates below unity. This result would imply substantial adjustment in real interest rates in response to changes in expected inflation. Many papers attempt to reinterpret the Fisher equation using movements in real interest rate. Levi and Makin (1978), Melvin (1982), and Peek and Wilcox (1983) prove that the decline in the marginal product of capital due to the real balance response to inflation, known also as the Mundell - Tobin effect, may have considerable significance.

Applying a simulation technique called Monte Carlo experiments, Mishkin (1992) takes the non-stationarity of inflation and nominal interest rates as a maintained hypothesis and applies Engle and Granger (1987) methodology to test for common stochastic trends. He finds that a strong Fisher effect occurs only during certain periods where inflation and interest rates have trends. He concludes that empirical evidence supports a long-run Fisher effect, but not a short-run Fisher effect. Crowder and Hoffman (1996) identify the mechanism responsible for the non-stationary behaviour of the system. Using a divaricated vector error correction model (VECM), they reveal a dynamic

behaviour of nominal interest rates and inflation. The VECM suggests a specific "causal" ordering where inflation has predictive content for the future course of the interest rates.

Using an expectations model of the term structure of interest rates, Wallace and Warner (1993) established the conditions under which innovations in short-term inflation will be transmitted to long-term, as well as short-term interest rates. They find that if inflation has a unit root in its time series process, then expectations of inflation in future periods will be dominated by the current period rate, which in turn will be co-integrated with long-term interest rates as well as short.

Evans and Lewis (1995) characterise the shifts in inflation by a Markov switching model. They argue that rational anticipations of infrequent shifts in the inflation process induce significant small sample biases in estimates of the long-run Fisher relationship. These small sample biases may create the appearance of permanent shocks to the real rates even when none are truly present. They examine the long-run relationship between nominal interest rates and inflation and are unable to reject the hypothesis that in the long-run nominal interest rates reflect expected inflation one-for-one.

Weidmann (1997) considers a threshold co-integration (TC) model to test for the Fisher effect. Using German data, he shows that the stochastic process governing the bivariate system of inflation and interest rates depends on the level of variables and can be designed as a TC model. The model explains the downward bias of the coefficient estimates, the country and sample sensitivity and supports the full Fisher hypothesis. However, the TC model is based on the assumption that the Bundesbank is committed to price stability and will not allow inflation rates to become negative or persistently

high. Therefore, the findings help to explain the Fisher effect only in countries where Central Banks are independent and have already built a long track credibility record.

Since the Fisher affect was proposed, despite the fact that various works have found a positive relationship between interest rates and inflation, the majority of the data from different economies supports the Fisher effect. There are some important issues to bear in mind. Hahn (1970) reports a negative relationship between inflation and interest rates. Juster and Wachtel (1972) also found evidence to support a negative relationship between inflation and interest rates.

In the study by Mishkin (1992), the authors suggested that studies that found the existence of a long run Fisher effect may actually detect the trend in the inflation rate and the trend in the interest rate, these two series may exhibit correlated trends and thus it results in the strong form Fisher effect. On the other hand, when interest rate and inflation do not exhibit trends, a strong correlation between interest rates and inflation rate will not appear if there is no short run Fisher effect. As a result, the existence of trend in the rate of inflation and interest rate determines the presence of the Fisher effect.

3.2 Monetary policy

Theoretically, monetary policy is one of the governmental policies that, in the short run, have the most profound effect on employment, production and exchange rates. However, in the long run, it affects only prices and inflation rates. For instance, in the short run, when the central bank increases money supply to the economy, the domestic interest rate drops immediately in response to the increase in loanable funds leading to a boost for production activities and the appreciation of the local currency. The adjustment of prices to such an increase in money supply only occurs in the long run, as

prices are sticky and respond very slowly to money shock. This is a drop in the real interest rate in the Fisher equation. In the long run, the rate of inflation will increase as prices adjust the supply and demand for money.

Romer and Romer (1989), using data from the US economy, found that when the government tightened the monetary policy the economy experienced a substantial decline in production and employment and the authors interpret their findings as strong evidence for the effect of monetary policy on real economic activity. In another study, Ball (1993) looked at data from OECD countries and supported further in recent history that when the governments underwent a restrictive money supply the economies experienced significant and sustained decline. In addition, Ball identified the fact that the country also experienced a period with output below trend. He asserts that the output effects are smaller (that is, reducing inflation is less costly) when the disinflation is rapid and when a country has more flexible labour contracts. Recently, in an attempt to confirm the strong negative effect of monetary policy on the economy, studies on the dynamic effects of monetary policy have taken a very different approach to the data, but they have reached broadly similar conclusions.

Researchers have agreed on a common methodology that is to try to identify the so called "monetary policy shocks" meaning movements in some measure of monetary policy that cannot be predicted or explained contemporaneously with the economic variables that typically drive monetary policy. The purpose of identifying these shocks is to apply statistical techniques to examine their possible effects on the fundamentals of the economy. As research efforts have intensified, it has become a consensus among economists that the exact timing is still a debatable issue, but a naive inference is that it commonly takes employment and production about six months to response to changes in monetary policy. Inflation however, takes a year or longer to show any effect.

Many empirical studies of the inflation process confirm that prices respond very slowly to changes in economic fundamentals. In studies of the Phillips curve, inflation is found to show significant lags; that is, inflation is strongly correlated with its own lagged values. To support the view that statistical technique can be used to solve economic puzzles, Ball (1993) applied advanced statistical techniques to identify monetary policy shocks and their effects; these shocks are found to have a gradual and delayed effect on the inflation rate. All findings of the research on this issue agree on the argument that central bank actions and inflation is one reason why central banks that have chosen to target inflation often look at expected inflation for some time ahead when judging whether they are on target.

The question here is why does monetary policy influence inflation with such a long lag? The answer is not at all obvious. Standard theories of the real effects of monetary policy emphasize the stickiness of wages or prices. The stickiness of prices can explain why the price level does not jump to a level ensuring full employment, but the inflation rate is determined by those prices that are changing, and those prices could respond quite quickly to changes in monetary policy.

There have, however, been several recent attempts to explain the sluggishness of inflation. These all depart significantly from standard models of price setting. But several of the attempts are similar in their underlying assumptions, and this common structure may well point the way toward a final resolution of the sluggish-inflation puzzle. The common assumption is that price setters are inattentive: prices keep rising after changes in monetary policy, because most price setters are not paying close attention to the policy change and, therefore, keep marking up prices as if no change has occurred.

4 Research Methodology and Data

4.1 The models

The relationship between nominal interest rates (*r),* real interest *(ρ)* and expected inflation *(i)* was first proposed by Irving Fisher (1930). This relationship can be mathematically described as:

$$1 + r_{t+1} = [1 + E_{t+1}\ (i)\ ][1 + E_{t+1}(\rho)] \qquad (1)$$

where r_{t+1} is future nominal interest rates, E_{t+1} *(i)* is expected future inflation rates, and $E_{t+1}(\rho)$ is the expected real interest rate

As the product $E(\ i_{t+1}\ )^*\ E_{t+1}(\rho\ )$ has been documented to be not significant and can be dropped out. Equation (1) can be written as:

$$r_{(t+1)} = E_{t+1}\ (\ i\ ) + E_{t+1}(\rho) \qquad (2)$$

where both E_{t+1} *(i)* and $E_{t+1}(\rho)$ are not observable and have to be proxied.

The Fisher hypothesis states that real rates of interest are stable. Therefore, the expected real rate can be expressed as a sum between a constant α and a stationary stochastic process ε_t

$$E_{t+1}(\rho\ ) = \alpha + \varepsilon_t \qquad (3)$$

Replacing the value of $E_{t+1}(\rho\ )$ from the above equation into equation (2) we have:

$$E_{t+1}(i) = |\alpha| + r_{(t+1)} - \varepsilon_t \qquad (4)$$

Equation (4) depicts the theoretical relationship between inflation and interest rate. In empirical research on the Fisher effect, $E_t(i)$ can be used as an explanatory variable and

$r_{(t)}$ can be the dependent variable. As a result, our investigation on the Fisher effect in China starts with the following model:

$$R_{it} = \alpha_0 + \beta_i CPI_t + \mu_{it} \qquad (5)$$

where CPI_t is the consumer price index, it is used as a proxy of expected inflation and

μ_{it} are residuals of the fitted equation (5).

Thus testing for the Fisher effect is equivalent to testing for $\beta_i = 1$.

4.2 Testing the Fisher effect

Given our data set is time series data; one needs to check for features of time series data that may invalidate the results. Granger and Newbold (1974) and Phillips (1986) point out that if the variables in a regression contain stochastic trends the results may be spurious. In this case, standard inference procedures are inappropriate. If inflation and interest rates contain unit roots, the framework for the analysis of non-stationary variables is the co-integration method. Currently, two main procedures are used to test for co-integration. One is the residual-based ADF method proposed by Engle and Granger (1987), and the other is Johansen's (Johansen, 1988, 1991) maximum likelihood approach. If the various deposit rates (Y_i) are found to be co-integrated with the CPI (X), then we can estimate the long-term relationship between them by estimating the following equation:

$$Y_i = a_i + b_i X + e_i \qquad (6)$$

The short-term relationship between the various deposit rates and CPI can be estimated by the following equation:

$$\Delta Y_i = c_i \Delta X + d_i e_i \qquad (7)$$

where ΔY_i denotes changes in deposit rate I, ΔX denotes changes in CPI and e_i is the error correction term.

4.3 The data

4.3.1 Definition of the data

The data we use for our study is time series data and consists of monthly nominal interest rates and monthly inflation rates. Since the data before 1993 are not available, our data sample period ranges from the 1st of July 1993 to the 1st of November 2005. Inflation rates are proxy by the yearly 1-year consumer price indices (CPI). The nominal interest rates are proxy by China's monthly 1-month demand deposit rates (DDR), monthly 6-month time deposit rates (TD6M), 1-year time deposit rates (TD1Y), 2-year time deposit rates (TD2Y), 3-year time deposit rates (TD3Y), and 5-year time deposit rates (TD5Y). In addition, the monthly 1-year time deposit rate (TD1Y) is the basic interest rate. All those rates are middle rates. The data are all taken from Thomson Financial and Datastream. Table 1 provides the summary of all variables.

Table 1 Variable Definition

Variable	**Description**
CPI	Consumer Price Index (YOY)
DDR	Demand deposit rate (Middle rate)
TD6M	6-month time deposit rate (Middle rate)
TD1Y	1-year time deposit rate (Middle rate)
TD2Y	2-year time deposit rate (Middle rate)
TD3Y	3-year time deposit rate (Middle rate)
TD5Y	5-year time deposit rate (Middle rate)

4.3.2 Numerical summaries and interpretations of the data

The characteristics of the time series data have been summarized in Table 2. The mean of DDR is the least one, only 1.6157%, compared with other six variables, while the others range between 4.3085% for TD6M to 6.6008% for TD5Y. The range of CPI is the largest one among all others from –2.20 t0 27.7. We can infer that CPI has the strongest fluctuant and got the negative minimum while demand deposit keeps the least fluctuant. Additionally, the data reveals that there are period/or periods of deflation in the Chinese economy giving a negative value of variable CPI during the periods from 1993 to 2005 in China.

Furthermore, it can be seen from the descriptive statistics of the variables that the independent variable CPI is the most varied variable indicating by its highest standard deviation 8.10. The DDR has the smallest 0.96 and others have a slight increase from 2.8374 to 4.5257 by 4%, 13.6%, 12%, 10.7% in order align with the duration of deposit rates from TD6M to TD5Y. In addition, when we look at the dispersion or spread in the series, CPI also appears to be the only variable that has an excess kurtosis greater than zero that means the peak of the density distribution of variable CPI is higher than that of the normal distribution while all other variables' density distribution has lower kurtosis than the normal distribution (platykurtic). Clearly, all variables follow positive (right skewed) distributions indicated by the positive values of skewness and their mean values are greater than the medians. Also notable and consistent with standard practice, the difference between the mean on interest rate of DDR and those on time deposits was quite large reflecting the premium paid to depositors for greater certainty of time deposits relative to the volatility of demand deposits. However, the variance of the mean of various time deposits categories is small.

Table 2 Summary of Descriptive Statistics on China's CPI, DDR, TD6M, TD1Y, TD2Y, TD3Y and TD5Y 1993:07-2005:11

	CPI	DDR	TD1Y	TD2Y	TD3Y	TD5Y	TD6M
Mean	5.3738	1.6158	5.1862	5.5752	5.9545	6.6008	4.3085
Median	1.6000	0.9900	2.2500	2.7000	3.2400	3.6000	2.1600
Maximum	27.7000	3.1500	10.9800	11.7000	12.2400	13.8600	9.0000
Minimum	-2.2000	0.7200	1.9800	2.2500	2.5200	2.7900	1.8900
Std. Dev.	8.1042	0.9595	3.6683	3.8605	3.9724	4.5257	2.8374
Skewness	1.3654	0.6885	0.6446	0.6668	0.6747	0.7159	0.7790
Kurtosis	3.5928	1.8503	1.7127	1.7331	1.7346	1.7937	1.9378

4.3.3 Examining correlation between the variables

Statically, fitting equation (5) to the data is equivalent to running a simple linear OLS regression of the CPI against the interest rates so the non-existence of a relationship between the dependent variable CPI and the explanatory variable interest rates is critical to the validity of our analysis. Thus, the Pearson's pair wise correlation has been used to examine the strength of the relationship. The results are reported in Table 3. The degree of correlation between CPI and interest rate is over 80% in each instance. Clearly, the correlation coefficient values in Table 3 indicate an almost perfect positive correlation between the CPI and interest rates at different maturities. More importantly, such strong correlations also flag the existence of the serial correlation.

Table 3 Correlation

Correlation	CPI	DDR	TD6M	TD1Y	TD2Y	TD3Y	TD5Y
CPI	1						
DDR	0.845499	1					
TD6M	0.874679	0.992799	1				
TD1Y	0.85206	0.990291	0.995674	1			
TD2Y	0.858621	0.989147	0.995904	0.999637	1		
TD3Y	0.861353	0.9881	0.994917	0.998382	0.99946	1	
TD5Y	0.870522	0.987636	0.995867	0.997189	0.998772	0.999598	1

In the following section, we are going to do the empirical analysis on the chosen data. The Granger causality test, unit root test and cointegration test will be done.

5 Empirical Analysis

A number of research studies on monetary policy in China have been conducted. However, few gave an explicit test on the Fisher effect. In this section, we test the Fisher equations applied to the data period from 1993 to 2005 in order to provide the empirical evidence that we discussed above.

We will use Granger (1987) to check the long-run Granger-cause ordering, and cointegration analysis promulgated by Johansen (1991) to check the relationship between interest rates and inflation. First, we conducted Pairwise Granger Causality Tests (PGCT) to determine the causal relationship between the two variables. Thorough checking of inflation is helpful in predicting interest rates, and thereby the dependent and independent variables are determined. We then check the properties of the variables by conducting the unit root tests to assess whether each variable is stationary or non-stationary. Following Johanson (1991), we then run a cointegration analysis to see if a stationary linear combination exists. If so, the times series data are cointegrated and there is a long run relationship between them. Finally, we run a vector error correction framework (VECM) to investigate the short-run relationship between the variables. All

the econometric analyses in this investigation will be done using the EViews version 5.0 software packages.

5.1 Is there a causal relationship?

Theoretically, a causal relationship results in a perfect correlation between variables, but a perfect correlation does not necessarily mean a causal relationship. Bearing this in mind, we conducted Pairwise Granger Causality Tests (PGCT) to assess whether CPI is Granger-caused by interest rates or vice-versa using a lag length of 12. The lag length was arbitrarily chosen, however, given the nature of the test that estimates the extent to which pass values of either variable is statistically significant in predicting the dependent variable there is a case for a fairly large lag length.

The test is based on the F-test for the joint significance of the coefficients of the independent variables in explaining the dependent variable. A formal approach to the determination of the optimal lag length such as the Final Prediction Error (FPE) or the Akaike Information Criteria (AIC) was not used. However, the F-tests results, which is the test statistics of the Analysis of Variance to test the joint hypothesis that the coefficient on the lagged times in each equation are equal to zero indicate that lags of DDR greater than six were not significant in predicting CPI. On the contrary, pass values of interest rates on time deposits were significant well past 6 lags. Therefore, a maximum lag length of six was chosen as the maximum period over which interest rates on all deposit categories were significant in Granger causing inflation.

The results of the tests are shown as Table 4 below. We can reject the hypothesis that DDR, TD6M, TD1Y, TD3Y and TD5Y does not Granger cause CPI, but we cannot reject the hypothesis that CPI does not Granger cause DDR, TD6M, TD1Y, TD3Y and

TD5Y. Therefore, it appears that Granger causality runs one-way from CPI to DDR, TD6M, TD1Y, TD3Y and TD5Y and not vice versa.

Therefore, based on this evidence we can say that there is a robust relationship between CPI and interest rates on deposits of various maturities. Accordingly, the underlying Fisher relation is supported in the case of China, given that CPI is useful in helping to predict interest rates on deposit categories.

Table 4 Pairwise Granger Causes Tests

Null Hypothesis:	Obs	F-Statistic	Probability
CPI does not Granger Cause DDR	143	1.83551	0.09702
DDR does not Granger Cause CPI		1.51808	0.17712
CPI does not Granger Cause TD6M	143	2.53092	0.02379
TD6M does not Granger Cause CPI		0.87445	0.51566
CPI does not Granger Cause TD1Y	143	3.23	0.00544
TD1Y does not Granger Cause CPI		0.75042	0.61015
CPI does not Granger Cause TD2Y	143	3.45819	0.00334
TD2Y does not Granger Cause CPI		0.67599	0.66924
CPI does not Granger Cause TD3Y	143	3.75604	0.00176
TD3Y does not Granger Cause CPI		0.51333	0.79739
CPI does not Granger Cause TD5Y	143	3.61084	0.00241
TD5Y does not Granger Cause CPI		0.55552	0.76494

Note: Results based on 6 Lags on each variable**.**

5.1.1 Unit root test

Applying to our data, we first ran a first-order autoregressive model wherein each variable against was regressed against each other in one-period lag. In each case, we found that the coefficient of the lagged time was approximately equal to one and significant at the 1% level indicating the presence of at least an AR (1) process.

For more confirmation of the presence of unit root in the data, we conducted both Augmented Dickey Fuller (ADF) and Phillip-Peron (PP) tests for unit roots on each

variable. Since we found that the trend component is not significant in both ADF and PP tests (see results from Table 5), we run the ADF and PP tests at intercept. The results of these tests are presented in Table 6 below.

Table 5 Summary of Unit Root Tests of Variables Including Trend

Augmented Dickey-Fuller Unit Root Test (ADF)

Variable	Test statistic at level	Prob.*	Critical value at 1% level	Test statistic with trend	Prob.*	ADF test statistic at 1st difference	Critical value at 1% level	Test statistic with trend	Prob.*	Trend at level/ 1st difference in ADF tests
CPI	-1.2059	0.9501	-4.0213	-0.2099	0.8340	-7.3599	-4.0217	0.8846	0.3378	Not significant
DDR	-2.6363	0.2650	-4.0213	-2.5871	0.0107	-15.9127	-4.0217	0.9428	0.3475	Not significant
TD6M	-1.1844	0.9095	-4.0213	-0.9291	0.3542	-14.3384	-4.0217	1.4016	0.1632	Not significant
TD1Y	-0.9145	0.9507	-4.0213	-0.6417	0.5521	-14.0084	-4.0217	1.4311	0.1546	Not significant
TD2Y	-0.7658	0.9655	-4.0213	-0.4322	0.6662	-13.8407	-4.0217	1.5269	0.1291	Not significant
TD3Y	-0.5810	0.9784	-4.0213	-0.1410	0.8881	-13.2605	-4.0217	1.5593	0.1211	Not significant
TD5Y	-0.6113	0.9767	-4.0213	-0.1598	0.8732	-13.3439	-4.0217	1.5878	0.1145	Not significant

* MacKinnon (1996) one-side p-value. Test at 1% level.
Note: P value for ADF test near zero (all significant at 1%).

Phillip-Peron

Variable	Test statistic at level	Prob.*	Critical value at 1% level	Test statistic with trend	Prob.*	ADF Test statistic at 1st difference	Critical value at 1% level	Test statistic with trend	Prob.*	Trend at level/ 1st difference in PP tests
CPI	-1.1403	0.9178	-4.0215	0.3148	0.7534	-7.3280	-4.0217	0.8846	0.3778	Not significant
DDR	-2.8381	0.1862	-4.0215	-2.5871	0.0107	-16.1322	-4.0217	0.9425	0.3475	Not significant
TD6M	-1.3910	0.8599	-4.0215	-0.9294	0.3542	-14.1908	-4.0217	1.4016	0.1632	Not significant
TD1Y	-1.0322	0.9354	-4.0215	-0.6417	0.5221	-14.0619	-4.0217	1.4311	0.1546	Not significant
TD2Y	-0.8718	0.9555	-4.0215	-0.4322	0.6662	-13.8808	-4.0217	1.5263	0.1291	Not significant
TD3Y	-0.5849	0.9782	-4.0215	-0.1410	0.8881	-13.3345	-4.0217	1.5593	0.1211	Not significant
TD5Y	-0.6367	0.9751	-4.0215	-0.1598	0.8732	-13.3856	-4.0217	1.5877	0.1145	Not significant

* MacKinnon (1996) one-side p-values. Test at 1% level.
Note: P value for ADF test near zero (all significant at 1%).

Table 6 Summaries of Unit Root Tests of Variables with Intercept

Augmented Dickey-Fuller Unit Root Test (ADF)

Variable	Test statistic at level	Prob.*	Critical value at 1% level	Adjust Test statistic at 1st difference*	Prob.*	Critical value at 1% level	Unit root in ADF tests
CPI	-1.486565	0.5378	-3.475184	-7.319082	0	-3.475184	Significant
DDR	-0.634278	0.8582	-3.474874	-15.95979	0	-3.475184	Significant
TD6M	-0.798773	0.8162	-3.474874	-14.26067	0	-3.475184	Significant
TD1Y	-0.796473	0.8169	-3.474874	-13.91539	0	-3.475184	Significant
TD2Y	-0.868285	0.7959	-3.474874	-13.72073	0	-3.475184	Significant
TD3Y	-1.015872	0.7468	-3.474874	-13.11991	0	-3.475184	Significant
TD5Y	-1.016793	0.7465	-3.474874	-13.19804	0	-3.475184	Significant

* MacKinnon (1996) one-side p-value. Test at 1% level.

Phillip-Peron

Variable	Test statistic at level	Prob.*	Critical value at 1% level	Adjust Test statistic at 1st difference*	Prob.*	Critical value at 1% level	Unit root in PP tests
CPI	-1.258108	0.648	-3.474874	-7.319082	0	-3.475184	Significant
DDR	-0.623458	0.8607	-3.474874	-16.2257	0	-3.475184	Significant
TD6M	-0.826097	0.8084	-3.474874	-13.99396	0	-3.475184	Significant
TD1Y	-0.799757	0.816	-3.474874	-13.7733	0	-3.475184	Significant
TD2Y	-0.871513	0.7949	-3.474874	-13.5877	0	-3.475184	Significant
TD3Y	-1.01553	0.7469	-3.474874	-13.10374	0	-3.475184	Significant
TD5Y	-1.017677	0.7462	-3.474874	-13.13263	0	-3.475184	Significant

* MacKinnon (1996) one-side p-values. Test at 1% level.

Not surprisingly, as shown by Table 6 Summaries of Unit Root Tests of Variables with Intercept, the results of the ADF and PP indicate the non-existence of a unit root between interest rates at all terms and the CPI. The results of Table 6 Summaries of Unit Root Tests of Variables with Intercept shows the null hypothesis (no unit root) is statistically rejected at a 1% level of significance and all the variables were non-stationary at the levels suggesting the presence of serial correlation. However, this non-stationarity was not due to the existence of trends as this was shown to be insignificant at the level in each variable (see Table 5). We repeated the tests at the first difference and found that the null hypothesis of a unit root was rejected at the 1% level. This confirms that the variables are integrated of order one I (1) given that they became stationary and integrated of order zero after first differencing.

Based on the previous discussion, to determine the linear association between interest rates on demand and time deposits of various maturities and the CPI in China, we utilise a model of the equation (5) $R_{it} = \alpha_0 + \beta_i CPI_t + \mu_{it}$, were R_t is a vector of interest rates and the error time μ_t satisfies the usual assumptions of the classical linear regression model with zero mean and constant variance. As expected, given that all variables were non-stationary at the levels, the Durbin Watson (DW) statistic of successive regressions of interest rate on CPI indicates the presence of serial correlation in the residuals.[3] A Breusch Godfrey Lagrange Multiplier (LM) test for serial correlation also confirmed that the coefficient of the one-period lagged residual was statistically significant. Likewise, an inspection of the correlograms of each variable indicated the presence of autocorrelation according to the Q-statistic advanced by Box-Pierce. Therefore, given the presence of unit roots and serial correlation, the estimation of equation (5) above would be spurious and misleading if the residuals of the model are not cointegrated. Consequently, in the next section we assess whether there are any stable long-run relationships between interest rates on deposits and inflation.

5.1.2 Testing for co-integration

Cointegration tests provided support for both the Fisher relationship in the short and long term, and the expectations theory of the term structure (Cooray, 2003). Given that the variables are non-stationary, a regression of one against the other would, *ceteris paribus,* result in a spurious regression. However, if the residuals of the regression of two similarly integrated variables are white noise and integrated of order zero, then according to Eagle and Granger (1987), the variables are cointegrated. In this case, the

[3] The D.W statistic was near zero in each case suggesting the presence of positive serial correlation.

estimated coefficients of the one-period lagged residuals give the long run relationship between the variables.

In testing for co-integration, we apply the procedure proposed by Engle and Granger (Engle & Granger, 1987) which is a residual based ADF method and Johansen's (1989; 1991) maximum likelihood approach. This procedure investigates whether the error terms of a regression of pairs of I (1) variable is stationary and integrated of order zero.

The Engle and Granger method involves two steps. Firstly, the long run relationship between inflation and interest rates is estimated using the method of ordinary least squares (OLS) that will result in the residuals of the regressions. Second, unit root tests for the residuals are carried out using an ADF test. In other words, the co-integration of E_{t-1} and $r_{(t)}$ in equation (5) is the implication of the long run Fisher effect. As the maximum likelihood approach developed by Johansen (1988), and Johansen and Juselius (1990) has been documented to be more robust empirically as their approach is not sensitive to the order of the variables in the cointegration test. However, a point worth noting here is that the determination of the number of cointegrating relations is sensitive to the assumption regarding the deterministic properties of the data, particularly the trend, which in turn affects the critical values of the test statistic. Mindful of this consideration, and in conjunction with earlier tests for the significance of a deterministic trend, we thought it may be appropriate to choose option 2 of the test assumption. Following the Johansen procedure we test whether the interest rate on each deposit type and CPI are cointegrated.

The results regarding the number of cointegrating equations are presented in Table 7 Trace and Maximum Eigenvalue Test Results. The Johansen cointegration test results are summarized in Table 8.

Using this assumption and a lag length of four in first differences, we found that at least one co-integrating relationship between CPI and interest rates on each deposit category. The investigation between CPI and DDR suggests no cointegrated relations under option 3, which assumes a linear trend. However, option 2, which assumes no linear trend and a restricted constant, revealed the existence of one cointegrating relationship according to the maximum eigenvalue test statistic. The trace statistic suggested no cointegrating relations under either option.

Table 7 Trace and Maximum Eigenvalue Test Results

Trace Test

Dependent Variable	Trace Statistic		Critical Value at 0.1		Prob.**	
	r=0	r=1	r=0	r=1	r=0	r=1
DDR	19.0640*	3.3773	17.9804	7.5567	0.0724	0.5127
TD6M	25.7149*	3.5564	17.9804	7.5567	0.0080	0.4822
TD1Y	29.4751*	3.4132	17.9804	7.5567	0.0020	0.5065
TD2Y	30.1037*	3.4182	17.9804	7.5567	0.0016	0.5056
TD3Y	29.1782*	3.3408	17.9804	7.5567	0.0023	0.5190
TD5Y	28.6934*	3.3811	17.9804	7.5567	0.0027	0.5120

Maximun Eigenvalue Test

Dependdent Variable	Trace Statistic		Critical Value at 0.1		Prob.**	
	r=0	r=1	r=0	r=1	r=0	r=1
DDR	15.6867*	3.3773	13.9059	7.5567	0.0538	0.5127
TD6M	22.1585*	3.5564	13.9059	7.5567	0.0045	0.4822
TD1Y	26.0620*	3.4132	13.9059	7.5567	0.0009	0.5065
TD2Y	26.6855*	3.4182	13.9059	7.5567	0.0007	0.5056
TD3Y	25.8375*	3.3408	13.9059	7.5567	0.0010	0.5190
TD5Y	25.3123*	3.3811	13.9059	7.5567	0.0013	0.5120

* denotes rejection of the hypothesis at the 0.1 level

**MacKinnon-Haug-Michelis (1999) p-values

Notes: Trend assumption: No deterministic trend (restricted

Lags interval (in first differences): 1 to 4

Table 8 Summary of the Johansen Cointegration Tests

Option 2	Trace test results	Max-Eigentrace results
DDR CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level
TD6M CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level
TD1Y CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level
TD2Y CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level
TD3Y CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level
TD5Y CPI	1 cointegrating eqn(s) at the 0.1 level	1 cointegrating eqn(s) at the 0.1 level

* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values
Note: lag intervals 1-4

5.1.3 Coefficients normalization

The coefficients of normalised long run relationships were presented in Table 9 Estimated Cointegration Coefficients (Normalised). The coefficients suggest that as inflation increases interest rates on all deposit categories increase as well. Also, in keeping with the underlying relationship between inflation and nominal interest rates, the reduction in the interest rate on deposits was due to a given increase in inflation increases with maturity. Hence, a 1% hike in inflation would reduce nominal interest rates on time deposits held for 1, 2 and 3 years on average by 0.42, 0.44 and 0.45 % respectively. All the coefficients are significantly different from zero, and all are different from one. It means that there is a long-term relationship that between the various deposit rates and CPI, but the coefficient is statistically significantly less than one.

Table 9 Estimated Cointegration Coefficients (Normalised)

Dependent Variable		DDR	TD6M	TD1Y	TD2Y	TD3Y	TD5Y
		1	1	1	1	1	1
Common Regressor	CPI	0.1069	0.3141	0.4213	0.4420	0.4548	0.5147
		0.0164	*0.0323*	*0.0409*	*0.0404*	*0.0416*	*0.0460*
Constant	C	0.7117	1.8475	0.4213	2.0308	2.3966	2.6601
		0.1638	*0.3257*	*0.0409*	*0.4130*	*0.4218*	*0.4648*

Notes: Standard errors are in italics
Estimates based on lag length 4

5.1.4 Test for the short run Fisher effect

The results of the error correction model are presented in Table 10. As can be seen from the table, all the error correction model (ECM) terms for interest rates on deposits are significant and with the correct sign. The F-statistic for joint significance of the lagged differenced terms is also all statistically significant at the 5% level. In each case, we observe that the speed of convergence due to short-terms shocks to the long run equilibrium path is approximately 5-7% per period/month. The critical value for the F-tests at 95% given the degrees of freedom of the numerator and denominator for 146 observations and 4 regressors is 3.78. As expected, the adjustment rate increases with deposits of longer maturity. In general, we found one cointegrating relationship between inflation and interest rates. In addition, the error vector terms were significant in all cases. It is interesting to note that none of the short-term relationship is significantly different from zero (not reported in the Table).

Table 10 Results of Error Correction Model

Dependent Variable	EC(-1)	t-statistics	F-statistic
D(DDR)	-0.0525	-3.2092	2.2038
D(TD6M)	-0.0681	-4.2111	3.6588
D(TD1Y)	-0.0603	-4.5619	4.3243
D(TD2Y)	-0.0641	-4.6528	4.5165
D(TD3Y)	-0.0667	-4.5285	4.3254
D(TD5Y)	-0.0706	-4.5196	4.3075

Note: A lag length of 2 selected.

6 Conclusions

This paper has studied the existence of the Fisher effect in the Chinese economy for the data period from July 1993 to November 2005. We found the interest rates and inflation rates in China are co-integrated. To examine co-integration we have used the Johansen's maximum likelihood approach and found at least one co-integrating relationship between CPI and interest rates on each deposit category. In order to capture both short and long run effect, we utilized a dynamic relationship among the variable using an error correction model and found insignificant Fisher effect in the short run.

As we discussed, the monetary policy in China has been politically driven, the finding that the Fisher effect does not exist in the short run, but in the long run only should not be taken with surprise. Our finding is consistent with that given by Berument, Ceylan and Olgun (2007); the authors conducted extensive research on the Fisher effect of 2 groups of countries, both developed and developing. They used different data sets and period of collection, but the same CPI and found that co-integration exists between CPI and the proxy of interest rate.

China's economy has been idolized by its remarkable growth rate at 9.5 percent during the last two decades. However, such achievement has been documented as attributable to an increasingly unsustainable investment boom with a rapid expansion of money and

bank credit since the mid-1990s. As we stated, monetary policy should have been used as an effective tool to correct such a situation. However, China's monetary policy has been overshadowed by the tightly managed exchange rate regime and a very inflexible interest rate setting mechanism. Those regimes prevent the Central Bank-the People's Bank of China from taking appropriate policy decisions to manage domestic demand, because of the fear that it could jeopardize political objectives set by the government (i.e., interest-rate hikes could encourage capital inflows and dampen the government's ability to control the exchange rate).

We strongly believe the Chinese economy needs a totally independent monetary policy that has no interference from political objectives, but is rather oriented to domestic objectives. This would enable the PBC to manage domestic demand by allowing interest rates to rise in accordance with changes driven by the market. This, in turn, requires a flexible exchange rate, not a revaluation of the currency.

References

Ball, L. (1993). *What determines the sacrifice ratio?* Cambridge: National Bureau of Economic Research Working Paper No. 4306.

Berument, H., & Jelassi, M. (2002). Fisher hypothesis: A multi-Country analysis. *Applied Economics, 34*, 1645-1655.

Boudoukh;, J., Richardson, M., Whitelaw, R. F., & . (1994). Industry Returns and the Fisher Effect. *The Journal of Finance, 49*(5), 1595-1615.

Carrasco, B. (Ed.). (2003). *Challenges in monetary policy: China special*. Manila: Deutsche Bank Research. www.dbresearch.com

China, T. P. s. B. o. (2004, September). *Monetary policy*. Retrieved July 7, 2005, from http://www.pbc.gov.cn/english/huobizhengce/

China, T. P. s. B. o. (2005). *Monetary policy*. Retrieved July 7, 2005, from www.pbc.gov.cn

Chinadaily. (2004, March 24). New emphasis on employment. Retrieved June 6, 2006, from www.chinadaily.com.cn

Cooray, A. (2003). The Fisher effect: A survey *Singapore Economic Review, 48*(2), 135-150.

Darby, M. (1975). The financial and tax effects of monetary policy on interest rates. *Economic Inquiry, 13*, 266± 276.

Economist, T. (2005, October 29). A great big banking gamble, 69 - 71.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation and testing. *Econometrica, 55*, 251-276.

Evans, M. D. D., & Lewis, K. K. (1995). Do long-term swings in the dollar affect estimates of the risk premia? *Review of Financial Studies, 8*(3), 709-742.

Feldstein, M. (1976). Inflation, income Taxes and the rate of interest: A theoretical analysis *American Economic Review, LXVI*, 809-820.

Fisher, I. (1896). Appreciation and interest. *AEA Publications, 3*(11), 331-442.

Fisher, I. (1930). *The theory of interest*. New York: Macmillan.

Goodfriend, M., & Prasad, E. (2005). Monetary policy implementation in China (Vol. Working paper No. 31): Bank of International Settlement.

Goodfriend, M., & Prasad, E. (2006). A framework for independent monetary policy in China.

Granger, C. W. J., & Newbold, P. (1974). Spurious regression in econometrics. *Journal of Econometrics, 2*, 111-120.

Hahn, F. H. (1970). Savings and uncertainty. *The Review of Economic Studies, 37*(1), 21-24.

Hakan, B., Nildag Basak, C., & Hasan, O. (2007). Inflation uncertainty and interest rates: Is the Fisher relation universal? *Applied Economics, 39*(1), 53.

Hoffman, D., & Crowder, W. (1996). The long-run relationship between nominal interest rates and inflation: The Fisher equation revisited. *Journal of Money, Credit and Banking, 28*(1), 102-118.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics & Control, 12*(2,3), 231-254.

Johansen, S. (1989). *Estimation and hypothesis testing of cointegrating: Vectors in Gaussian Vector autoregressive models*.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models. *Econometrica, 6*, 1551-1580.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics, 52*(2), 169-210.

Juster, F. T., & Wachtel, P. (1972). A note on inflation and the saving rate. *Brookings Papers on Economic Activity, 3*, 765-778.

Kang, J., Liu, M.-H., & Ni, S. X. (2002). Contrarian and momentum strategies in the China stock market 1993 -2000. *Pacific Basin Finance Journal*, 243 - 265.

Laurens, B. J., Maino, R., & Stella, P. (2007). *China: Strengthening monetary Policy implementation*: Monetary and Capital Markets Department IMF.

Levi, M. D., & Makin, J. H. (1978). Anticipated inflation and interest rates: Further interpretation of findings on the Fisher equation. *The American Economic Review, 68*(5), 801-812.

Liu, M. H., Margaristis, D., & Rad, A. T. (2006). Monetary policy and deposit rates rigidity in a transitional economy: The case of China. Auculand University of Technology.

Melvin, M. (1982). Expected inflation, taxation, and interest rates: The delusion of fiscal illusion. *The American Economic Review, 72*(4), 841.

Mishkin, F. S. (1992). Is the Fisher effect for real? : A reexamination of the relationship between inflation and interest rates. *Journal of Monetary Economics, 30*, 195-215.

Peek;, J., & Wilcox, J. A. (1983). The postwar stability of the Fisher effect. *The Journal of Finance, 38*(4), 1111-1124.

Phillips, P. C. B. (1986). Understanding spurious regressions in econometrics. *Journal of Econometrics, 33*, 311-340.

Phillips, P. C. B. (2005). Econometric analysis of Fisher's equation. *The American Journal of Economics and Sociology, 64*(1).

Romer, C. D., & Romer, D. H. (1989). *Does monetary policy matter? A new test in the spirit of Friedman and Schwarts*. Cambridge: National Bureau of Economic Research Working Paper No. 2966.

Rose, A. K. (2007). A stable international monetary system emerges: Inflation targeting is Bretton Woods, reversed. *Journal of International Money and Finance, 26*(5), 663-681.

Sun, Q., & Tong, W. H. S. (2000). The effect of market segmentation on stock price: The China syndrome,. *Journal of banking and finance, 24*.

Tanzi, V. (1976). Inflation, Indexation and Interest Income Taxation. *Banca Nazionaledel Lavoro Quarterly Review, 29*, 54-76.

Vidaillet, T., & Chen, E. (2007). Chinese Investment Quickens, Fuels Tightening Talk. Retrieved June 15, 2007, from http://www.bnet.com/2407-13071_23-88481.html

Wallace, M. S., & Warner, J. T. (1993). The Fisher effect and the term structure of interest rates: Tests of cointegration. *The Review of Economics and Statistics, 75*(2), 320-324.

Weidmann, J. (1997). New hope for the Fisher effect? A re-examination using threshold cointegration. *Macroeconomics*. Retrieved May 25, 2005, from http://ideas.repec.org/p/wpa/wuwpma/9705005.html

Xinhua. (2006, June 9). Economy sizzles, bank loans surge. *Xinhua*. Retrieved June 20, 2006, from http://www.chinadaily.com.cn/china/2006-06/09/content_612988.htm

Yuhn, K.-H. (1996). Is the Fisher effect robust? Further evidence. *Applied Economics Letters, 3*, 41-44.

Zhou, X. (2005, March, 2005). Exclusive interview with the People's Daily. *The People's Daily*.

Appendix A: Inflation targeting countries through 2004

Table 11 Inflation Targeting Countries through 2004

Inflation trageting countries through 2004		
	Dafault start date	Conservative start date
Australia	March 1993	September 1994
Brazil	June 1999	June 1999
Canada	February 1991	January 1992
Chile	January 1991	August 1999
Colombia	September 1999	October 1999
Czech Republic	January 1998	January 1998
Finland	February 1993	Januray 1994
Hungary	June 2001	August 2001
Iceland	March 2001	March 2001
Israel	January 1992	June 1997
Korea	April 1998	April 1998
Mexico	January 1999	January 2001
New Zealand	March 1990	March 1990
Norway	March 2001	March 2001
Peru	January 2002	January 2002
Philippines	January 2002	January 2002
Poland	September 1998	September 1998
South Africa	February 2000	February 2000
Spain	January 1995	January 1995
Sweden	January 1993	January 1995
Switzerland	January 2000	January 2000
Thailand	May 2000	May 2000
United Kingdom	October 1992	October 1992

Note: USA has a mixed objective monetary policy using inflation targeting as a tool. Since there is not a clear precisely when inflation targeting began, we give the "default start date" to presents the scholars view and the "Conservation start date" to present the official statement (Rose, 2007). All the sources are from Rose (2007).